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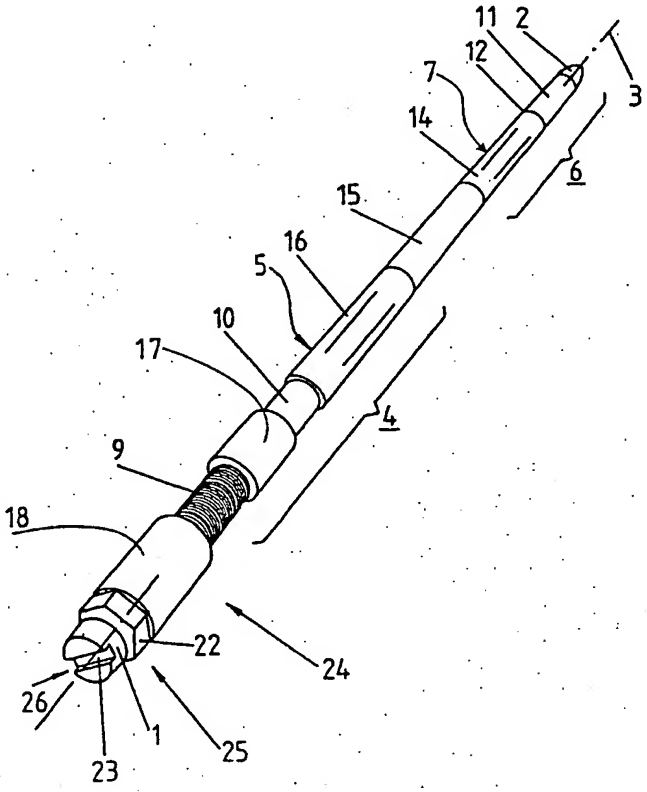
(54) Title: RADIALLY EXPANDABLE INTRAMEDULLARY NAIL



(57) Abstract: Intramedullary nail for fixation of bone fractures with a head (1), a tip (2) and a longitudinal axis (3), whereby a first radially expandable section (5) is provided in the proximal section (4) adjacent to the head (1) of the intramedullary nail; a second radially expandable section (7) is provided in the distal section (6) adjacent to the tip (2) of the intramedullary nail; and a non-expandable middle section (8) is provided between said two radially expandable sections (5, 7) of the intramedullary nail.

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Radially expandable intramedullary nail

This invention concerns an intramedullary nail in accordance with the pre-characterising portion of Claim 1.

Various types of intramedullary nails are already known in the state of the art, which are expandable in a limited section of the nail in order to allow the fixation of the nail against the bone cortex, e.g. by means of radially deploying a number of blades in the distal portion of the intramedullary nail.

The disadvantages of these known devices consist in:

a) The fact that the nail is not extrafocal and so is not consistent with the state of art concept of fracture treatment. The largest expansion of the nail is in the fracture area, which affects negatively the endosteal vascularisation just in the fracture area, i.e. the most important area;

b) The largest expansion of the nail in the fracture area generates forces which have the tendency to separate the fragments in comminuted fractures or, in the case of longitudinal non-dislocated fractures to increase the gap and to dislocate fragments which leads to loosening of the fixation.

The invention as claimed aims at solving the above described problems and disadvantages.

The present invention provides an intramedullary nail as defined in claim 1.

The nail according to the invention allows to obtain the following advantages:

a) The expandable parts of the nail are located extrafocally, leaving the fracture area minimally affected from radial forces;

b) the nail is particularly strong in the middle part – between the proximal and distal sections - of the nail

c) no fluoroscopy is needed for distal nor proximal locking since the expandable parts are fastened via tightening a nut on a thread in the longitudinal direction of the intramedullary nail.

The intramedullary nail according to the invention comprises a first radially expandable section provided in the proximal section adjacent to the head of the intramedullary nail, a second radially expandable section provided in the distal section adjacent to the tip of the intramedullary nail and a non-expandable middle section provided between said two radially expandable sections of the intramedullary nail.

The head provides a distraction mechanism, by means of which said two radially expandable sections are distractible transverse to said longitudinal axis.

In a preferred embodiment of the intramedullary nail according to the invention the non-expandable section of the intramedullary nail has a length in the range of 10 to 25 mm, preferably in the range of 15 to 22 mm.

Furthermore, the intramedullary nail consists of a solid nail core with a head and a tip. In the proximal section adjacent to the head a thread is provided. The middle section of the core is configured with a smaller diameter than the end section of the core such that the middle section and the end section are separated by an annular abutment. Apart from the core the intramedullary nail according to this embodiment comprises two longitudinally slotted tubular pieces that provide the first and second radially expandable sections, two unslotted tubular pieces and a nut. These elements are slid over the core in the following sequence:

- a slotted tubular piece
- an unslotted tubular piece
- a slotted tubular piece
- an unslotted tubular piece

such that adjacent to the tip of the nail a first slotted tubular piece is provided. The second slotted tubular piece is separated from the first one by means of an unslotted tubular piece. Adjacent to the end of the nail a nut with an interior thread corresponding to a thread on the core is mounted such allowing to compress the tubular pieces along the longitudinal axis. When these element are aligned on the core a screwing of the nut onto the thread on the core - by means of a driving means such as a spanner, wrench or similar tool engaged to suitable means at the nut such

as two parallel sides, hexagonal sides, a hexagon socket or the like - and holding up the core against rotation - by means of a second tool inserted into corresponding suitable means at the core such as a slot, hexagon socket or the like - will produce an axial force or compression on the tubular pieces as soon as the first slotted tubular piece abuts against the abutment of the core and the nut is tightened. Under that compression force the belts between the cuts at the slotted tubular pieces begin to buckle and deform radially such causing a radial expansion of the slotted tubular pieces. By this effect the nail expands at a first radially expandable section in the proximal section adjacent to the head of the nail and in a second radially expandable section in the distal section adjacent to the tip of the nail.

A further embodiment of the intramedullary nail according to the invention differentiates from the above embodiment therein that it provides instead of the core a hollow cylindrical or prismatical sleeve extending along the longitudinal axis and surrounding a rodlike locking element coaxially to the longitudinal axis. The locking element comprises a shaft with a thread in the proximal section towards the head of the nail and a projection forming an abutment in the distal section. In the distal section the sleeve provides a slot penetrating the side wall through to the bore such that the projection of the locking element may slide within said slot in the direction of the longitudinal axis. Once the tubular elements are aligned on the sleeve as mentioned above the tightening of the nut on the thread on the locking element while holding up the locking element against rotation causes a compression force onto the tubular elements clamped between the nut and the abutment producing the same effect as described in the above embodiment of the intramedullary nail.

A third preferred embodiment of the intramedullary nail comprises five elements: a nut, a hollow proximal section, a hollow middle section and a hollow distal section and a central wire. Contact between the proximal section and the middle section is represented by first abutments transversely arranged relative to the longitudinal axis while contact between the middle section and the distal section is represented by second abutments transversely arranged relative to the longitudinal axis. The central wire is fixed in the distal section and runs through a hollow channel of the other sections. At its proximal end the central wire provides threads which correspond to the interior threads of the nut.

When the nut is tightened a sliding of the proximal section and distal section on the first and second transverse abutments respectively is produced. If the intramedullary channel of the femur has a larger in diameter than the intramedullary nail the proximal section and distal section will expand transversely to the longitudinal axis until firm fixation of the bone fragments is reached. This radial expansion is possible because the first and second transverse abutments enclose an angle of between 5° and 85° with the longitudinal axis such that upon applying a force in the axial direction by means of tightening the nut the proximal section, the middle section and the distal section slide on the abutments providing a sliding component orthogonal to the longitudinal axis what causes a radial expansion of the intramedullary nail.

The middle section may provide sharp radial teeth that prevent axial displacement of the bone fragments after fixation of the nail.

Yet, another embodiment of the intramedullary nail according to the invention comprises basically three elements: a nut with a head and a conical tip, a central wire with a cone like distal end and a hollow intramedullary nail. The ends of the intramedullary nail are provided with a plurality of cuts such forming contact studs that are radially expandable within the intramedullary channel of the bone. The central wire runs through the hollow channel of the intramedullary nail and – at its proximal end - has threads which correspond to the interior threads of the nut. When the nut is tightened the distance between the conical tip of the nut and the cone like distal end of the central wire is shortened, so that the contact studs of the intramedullary nail are expanded by means of the radial forces caused by the axial displacement of the cones. This expansion of the intramedullary nail proximally and distally produces a firm fixation of the bone fragments of the femur.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming part of this disclosure. For the better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings, examples and descriptive matter in which are illustrated and described preferred embodiments of the invention.

In the drawings:

Fig. 1 shows a schematic representation of an intramedullary nail according to the invention in the non-expanded state;

Fig. 2 shows an exploded view of the intramedullary nail according to Fig. 1;

Fig. 3 shows a schematic representation of one of the expandable sections of the intramedullary nail according to Fig. 1 in the non-expanded and in the expanded state;

Fig. 4 shows a schematic representation of an intramedullary nail according to the invention in the expanded state;

Fig. 5 shows a second embodiment of an intramedullary nail according to the invention;

Fig. 6 shows a variation of the nut to be used with the intramedullary nail according to Fig. 5;

Fig. 7 shows a third embodiment of an intramedullary nail according to the invention and in the non-expanded state;

Fig. 8 shows the intramedullary nail according to Fig. 7 in the expanded state;

Fig. 9 shows the intramedullary nail according to Fig. 7 implanted in a femur bone and in the expanded state;

Fig. 10 shows a fourth embodiment of an intramedullary nail according to the invention in the expanded state; and

Fig. 11 shows a the intramedullary nail according to Fig. 10 implanted in a femur bone and in the expanded state.

Figures 1 to 4 show a first embodiment of the invention which consists of a solid nail core 10 with a head 1 and a tip 2 and a longitudinal axis 3. In the proximal section 4 adjacent to the head 1 a tread 9 is provided. The middle section 13 of the core 10 has smooth surface and a tapering diameter towards the distal section 6 adjacent to the tip 2. The middle section 13 of the core 10 - with a minor diameter - and the end section 11 of the core 10 - with a larger diameter - are separated by an annular abutment 12.

As shown in Fig. 2 the following elements are slid over the core 10 in the following sequence:

- a slotted tubular piece 14
- an unslotted tubular piece 15
- a slotted tubular piece 16
- an unslotted tubular piece 17
- a nut 18 with an inner thread corresponding with thread 9.

When these element are aligned on the core 10 a screwing of the nut 18 - by means of the two parallel sides or hexagonal sides 22 - on the thread 9 and holding up the core 10 - by means of the slot 23 - will produce an axial force or compression (as indicated by arrows 19 in Fig. 3) on the tubular pieces (17,16,15,14) as soon as the slotted tubular piece 14 abuts against the abutment 12 of the core 10. As shown in Fig. 3 the cuts 20 of the slotted tubular piece 14 - as well as those of slotted tubular piece 16 - will cause an expansion of the slotted tubular piece 14 by radially deforming the belts 21 located between the cuts 20.

By this effect the nail expands - as shown in Fig. 4 - at a first radially expandable section 5 in the proximal section 4 adjacent to the head 1 of the nail and in a second radially expandable section 7 in the distal section 6 adjacent to the tip 2 of the nail. Instead of the two parallel sides or hexagonal sides 22 and the slot 23 for tightening the nut 18 two hexagon sockets may be placed.

Fig. 5 and 6 show a second embodiment of the intramedullary nail which differentiates from the embodiment shown in Fig. 1 – 4 therein that it provides instead of the core 10 a hollow cylindrical sleeve 35 extending along the longitudinal axis 3 and

surrounding a locking element 32 coaxially to the longitudinal axis 3. The locking element 32 comprises a shaft with a thread 41 in the proximal section 4 and in the distal section 6 a projection 31 forming an abutment 39. In the distal section 6 the sleeve 35 provides a slot 34 penetrating the side wall through to the bore 33 such that the projection 31 of the locking element 32 may slide within said slot 34 in the direction of the longitudinal axis 3. The following elements are slid over the sleeve 35 in the following sequence:

- a slotted tubular piece 14
- an unslotted tubular piece 15
- a slotted tubular piece 16
- an unslotted tubular piece 17
- an end cap 42
- a nut 40 with an inner thread corresponding with thread 41.

Once these elements are aligned on the sleeve 35 the tightening of the nut 40 on the thread 41 while counter holding the locking element 32 by means of the hexagon socket 43 axially compresses the tubular pieces 14;15;16;17 as soon as the slotted tubular piece 14 abuts against the abutment 39 formed by the projection 31 of the locking element 32. Equally as in case of the first embodiment the belts 21 of the slotted tubular pieces (14;16) buckle and radially expand under the axial forces 19 (Fig. 3). Instead of the nut 40 and the end cap 42 another end cap 36 providing in interior thread 38 corresponding with thread 41 and a hexagon socket 37 may be used (Fig. 6).

Figs. 7 to 9 show a third embodiment of the intramedullary nail which consists basically of five elements: a nut 50, a hollow proximal section 51, a hollow middle section 52 and a hollow distal section 53 and a central wire 54. Contact between the proximal section 51 and the middle section 52 is represented by transverse abutments 55 (relative to the longitudinal axis 3). Contact between middle section 52 and distal section 53 is represented by transverse abutments 56 (relative to the longitudinal axis 3). The central wire 54 is fixed in the distal section 53 and runs through the hollow channel 59 of sections 51,52,53. At its proximal end the central wire 54 has threads 57 which correspond to the interior threads 58 of the nut 50. When the nut 50 is turned by means of a key 60 the central wire 54 is tightened and produces sliding of the proximal section 51 and distal section 53 on the transverse

abutments 55 and 56 respectively. If the intramedullary channel 61 of the femur 62 (Fig. 9) has a larger in diameter than the intramedullary nail the proximal section 51 and distal section 53 will expand radially until firm fixation of the bone fragments 63 and 64. This radial expansion is possible because the transverse abutments 55;56 enclose an angle of between 5° and 85° with the longitudinal axis 3 such that upon applying a force in the axial direction by means of tightening the nut 50 the proximal section 51, the middle section 52 and the distal section 53 slide on the abutments 55;56. Because the abutments 55;56 enclose an angle with the longitudinal axis 3 the sections 51;52;53 opposing each other at one abutment 55;56 each provide a sliding component orthogonal to the longitudinal axis 3 what causes a radial expansion of the intramedullary nail.

The sharp radial teeth 65 in the middle section 52 prevent axial displacement of the bone fragments 63,64 after its fixation.

Figs. 10 and 11 show a fourth embodiment of the intramedullary nail which consists basically of three elements: a nut 71 with head 1 and conical tip 78, a central wire 72 with a cone like distal end 73 and a hollow intramedullary nail 73. The ends of the intramedullary nail 73 are provided with a plurality of cuts 74. The central wire 72 runs through the hollow channel 75 of the intramedullary nail 73 and - at its proximal end – has threads 76 which correspond to the interior threads 77 of the nut 71. When the nut 71 is turned by means of a key 60 the distance between the conical tip 78 of the nut 71 and the cone like distal end 73 of the central wire 72 is shortened, so that the cuts 74 of the intramedullary nail 73 are expanded as shown in Fig. 11. The expansion of the intramedullary nail 73 proximally and distally at sections 5 and 7 produces a firm fixation of the bone fragments 63 and 64 of the femur 62.

While the foregoing description and drawings represent the preferred embodiments of the present invention, it will be obvious for those skilled in the art that various changes and modifications may be made therein without departing from the scope of the present invention.

Claims

1. Intramedullary nail for fixation of bone fractures with a head (1), a tip (2) and a longitudinal axis (3),
characterized in that,
A) a first radially expandable section (5) is provided in the proximal section (4) adjacent to the head (1) of the intramedullary nail;
B) a second radially expandable section (7) is provided in the distal section (6) adjacent to the tip (2) of the intramedullary nail;
C) a non-expandable middle section (8) is provided between said two radially expandable sections (5,7) of the intramedullary nail.

2. Intramedullary nail according to claim 1, characterized in that the head (1) is provided with a distraction mechanism (24), by means of which said two radially expandable sections (5,7) are distractible transverse to said longitudinal axis (3).

3. Intramedullary nail according to claim 1 or 2, characterized in that it comprises a core (10) and at least two slotted tubular pieces (14;16) that provide the first and second radially expandable sections (5;7).

4. Intramedullary nail according to claim 3, characterized in that the core (10) provides a middle section (13) - with a minor diameter - and a an end section (11) adjacent to the tip (2) - with a larger diameter - whereby these two sections (11;13) are separated by an annular abutment (12).

5. Intramedullary nail according to claim 4, characterized in that the slotted tubular pieces (14;16) are configured slidable on the middle section (13) and prevented from sliding on the end section (11) towards the tip (2) by means of the annular abutment (12).

6. Intramedullary nail according to one of the claims 1 to 5, characterized in that it comprises at least one unslotted tubular piece (15) providing the non-expandable middle section (8).

7. Intramedullary nail according to one of the claims 2 to 6, characterized in that the distraction mechanism (24) comprises a thread (9) on the core (10) adjacent to the head (1) and a nut (18) with an interior thread corresponding with thread (9).

8. Intramedullary nail according to one of the claims 1 to 7, characterized in that said non-expandable section (8) of the intramedullary nail has a length in the range of 10 to 25 mm.

9. Intramedullary nail according to claim 8, characterized in that said non-expandable section (8) of the intramedullary nail has a length in the range of 15 to 22 mm.

10. Intramedullary nail according to one of the claims 7 to 9, characterized in that the tubular pieces (14;15;16;17) are slid over the core (10) in the sequence: a slotted tubular piece (14), an unslotted tubular piece (15), a slotted tubular piece (16) and an unslotted tubular piece (17) and at last the nut (18) is screwed over the thread (9).

11. Intramedullary nail according to one of the claims 7 to 10, characterized in that the nut (18) comprises means (25) for engagement of a driving means.

12. Intramedullary nail according to one of the claims 3 to 11, characterized in that the core (10) comprises means (26) for engagement of a holding means.

13. Intramedullary nail according to claim 11 or 12, characterized in that the means (25) for engagement of a driving means are hexagonal sides (22).

14. Intramedullary nail according to claim 12 or 13, characterized in that the means (26) for engagement of a holding means is a slot (23).

15. Intramedullary nail according to one of the claims 1, 2, 8 or 9, characterized in that it comprises a hollow sleeve (35) extending along the longitudinal axis (3) and surrounding a locking element (32) coaxially to the longitudinal axis 3.

16. Intramedullary nail according to claim 15, characterized in that the locking element (32) comprises a shaft with a thread (41) in the proximal section (4) and in the distal section (6) a projection (31) forming an abutment (39)

17. Intramedullary nail according to claim 15 or 16, characterized in that in the distal section (6) the sleeve (35) provides a slot (34) penetrating the side wall through to the bore (33) such that the projection (31) of the locking element (32) may slide within said slot (34) in the direction of the longitudinal axis (3).

18. Intramedullary nail according to one of the claims 15 to 17, characterized in that it further comprises at least two slotted tubular pieces (14;16) that provide the first and second radially expandable sections (5;7).

19. Intramedullary nail according to one of the claims 16 to 18, characterized in that the slotted tubular pieces (14;16) are configured slidable on the sleeve (35) and prevented from sliding on the end section (11) towards the tip (2) by means of the abutment (39).

20. Intramedullary nail according to one of the claims 15 to 19, characterized in that it comprises at least one unslotted tubular piece (15) providing the non-expandable middle section (8).

21. Intramedullary nail according to one of the claims 2 or 15 to 20, characterized in that the distraction mechanism (24) comprises a thread (41) on the locking element (32) adjacent to the head (1) and a nut (40) with an interior thread corresponding with thread (41).

22. Intramedullary nail according to claim 21, characterized in that the nut (40) comprises means (25) for engagement of a driving means.

23. Intramedullary nail according to claim 21 or 22, characterized in that the locking element (32) comprises means (43) for engagement of a holding means.

24. Intramedullary nail according to one of the claims 2 or 15 to 20, characterized in that the distraction mechanism (24) comprises a thread (41) on the locking element (32) adjacent to the head (1) and an end cap (36) with an interior thread (38) corresponding with thread (41).

25. Intramedullary nail according to claim 24, characterized in that the end cap (36) comprises means (37) for engagement of a driving means.

26. Intramedullary nail according to claim 24 or 25, characterized in that the locking element (32) comprises means (43) for engagement of a holding means.

27. Intramedullary nail according to claim 1 or 2, characterized in that it comprises a nut (50), a hollow proximal section (51), a hollow middle section (52) and a hollow distal section (53) and a central wire 54, whereby

A) contact between the proximal section (51) and the middle section (52) is represented by transverse abutments (55) (relative to the longitudinal axis 3);

B) contact between middle section (52) and distal section (53) is represented by transverse abutments (56) (relative to the longitudinal axis 3);

C) the central wire (54) is fixed in the distal section (53) and runs through the hollow channel (59) of sections (51,52,53);

D) at its proximal end the central wire (54) has threads (57) which correspond to the interior threads (58) of the nut (50); and

E) the transverse abutments (55;56) are configured at an angle of between 0,1° and 89,9° with the longitudinal axis (3) such that upon applying a force in the axial direction by means of tightening the nut (50) the proximal section (51), the middle section (52) and the distal section (53) also provide a sliding component orthogonally to the longitudinal axis (3) on the abutments (55;56).

28. Intramedullary nail according to claim 27, characterized in that the middle section (52) provides sharp radial teeth (65) preventing axial displacement of the bone fragments (63,64) after its fixation.

29. Intramedullary nail according to claim 23 or 24, characterized in that the distraction mechanism (24) comprises a thread (57) on the wire (54) adjacent to the head (1) and the nut (50) with a interior thread (58) corresponding with thread (9).

30. Intramedullary nail according to claim 29, characterized in that the nut (50) comprises means (25) for engagement of a driving means.

31. Intramedullary nail according to claim 29 or 30, characterized in that the wire (54) comprises means for engagement of a holding means when the nut (50) is tightened.

32. Intramedullary nail according to claim 1 or 2, characterized in that it comprises a nut (71) with head (1) and conical tip (78), a central wire (72) with a cone like distal end 73 and a hollow intramedullary nail (73).

33. Intramedullary nail according to claim 32, characterized in that the ends of the intramedullary nail (73) are provided with a plurality of cuts (74) while the central wire (72) runs through the hollow channel (75) of the intramedullary nail (73) and - at its proximal end - has threads (76) which correspond to the interior threads (77) of the nut (71).

34. Intramedullary nail according to claim 33, characterized in that the nut (71) comprises means for engagement of a driving means.

35. Intramedullary nail according to claim 33 or 34, characterized in that the central wire (72) comprises means for engagement of a holding means when the nut (71) is tightened.

AMENDED CLAIMS

[received by the International Bureau on 10 November 2000 (10.11.00);
original claims 1-35 replaced by new claims 1-19 (3 pages)]

1. Intramedullary nail for fixation of bone fractures with a head (1), a tip (2) and a longitudinal axis (3), whereby

A) a first radially expandable section (5) is provided in the proximal section (4) adjacent to the head (1) of the intramedullary nail;

B) a second radially expandable section (7) is provided in the distal section (6) adjacent to the tip (2) of the intramedullary nail;

C) a non-expandable middle section (8) is provided between said two radially expandable sections (5,7) of the intramedullary nail,

characterized in that

D) the intramedullary nail comprises a hollow cylindrical sleeve (35) extending along the longitudinal axis (3) and surrounding a locking element (32) coaxially to the longitudinal axis (3).

2. Intramedullary nail according to claim 1, characterized in that the head (1) is provided with a distraction mechanism (24), by means of which said two radially expandable sections (5,7) are distractible transverse to said longitudinal axis (3).

3. Intramedullary nail according to claim 1 or 2, characterized in that it comprises at least one unslotted tubular piece (15) providing the non-expandable middle section (8).

4. Intramedullary nail according to claim 3, characterized in that said non-expandable section (8) of the intramedullary nail has a length in the range of 10 to 25 mm.

5. Intramedullary nail according to claim 4, characterized in that said non-expandable section (8) of the intramedullary nail has a length in the range of 15 to 22 mm.

6. Intramedullary nail according to one of the claims 3 to 5, characterized in that the tubular pieces (14;15;16;17) are slid over the sleeve (35) in the sequence: a slotted tubular piece (14), an unslotted tubular piece (15), a slotted tubular piece (16) and an unslotted tubular piece (17) and at last the nut (18) is screwed over the thread (9).

7. Intramedullary nail according to claim 6, characterized in that the nut (18) comprises means (25) for engagement of a driving means.

8. Intramedullary nail according to one of the claims 1 to 7, characterized in that the sleeve (35) comprises means (26) for engagement of a holding means.

9. Intramedullary nail according to claim 7 or 8, characterized in that the means (25) for engagement of a driving means are hexagonal sides (22).

10. Intramedullary nail according to claim 8 or 9, characterized in that the means (26) for engagement of a holding means is a slot (23).

11. Intramedullary nail according to one of the claims 1 to 10, characterized in that the locking element (32) comprises a shaft with a thread (41) in the proximal section (4) and in the distal section (6) a projection (31) forming an abutment (39)

12. Intramedullary nail according to claim 11, characterized in that in the distal section (6) the sleeve (35) provides a slot (34) penetrating the side wall through to the bore (33) such that the projection (31) of the locking element (32) may slide within said slot (34) in the direction of the longitudinal axis (3).

13. Intramedullary nail according to one of the claims 1 to 12, characterized in that it further comprises at least two slotted tubular pieces (14;16) that provide the first and second radially expandable sections (5;7).

14. Intramedullary nail according to claim 13, characterized in that the slotted tubular pieces (14;16) are configured slidable on the sleeve (35) and prevented from sliding on the end section (11) towards the tip (2) by means of the abutment (39).

15. Intramedullary nail according to one of the claims 2 to 14, characterized in that the distraction mechanism (24) comprises a thread (41) on the locking element (32) adjacent to the head (1) and a nut (40) with an interior thread corresponding with thread (41).

16. Intramedullary nail according to claim 15, characterized in that the nut (40) comprises means (25) for engagement of a driving means.

17. Intramedullary nail according to claim 15 or 16, characterized in that the locking element (32) comprises means (43) for engagement of a holding means.

18. Intramedullary nail according to one of the claims 2 to 17, characterized in that the distraction mechanism (24) comprises a thread (41) on the locking element (32) adjacent to the head (1) and an end cap (36) with an interior thread (38) corresponding with thread (41).

19. Intramedullary nail according to claim 18, characterized in that the end cap (36) comprises means (37) for engagement of a driving means.

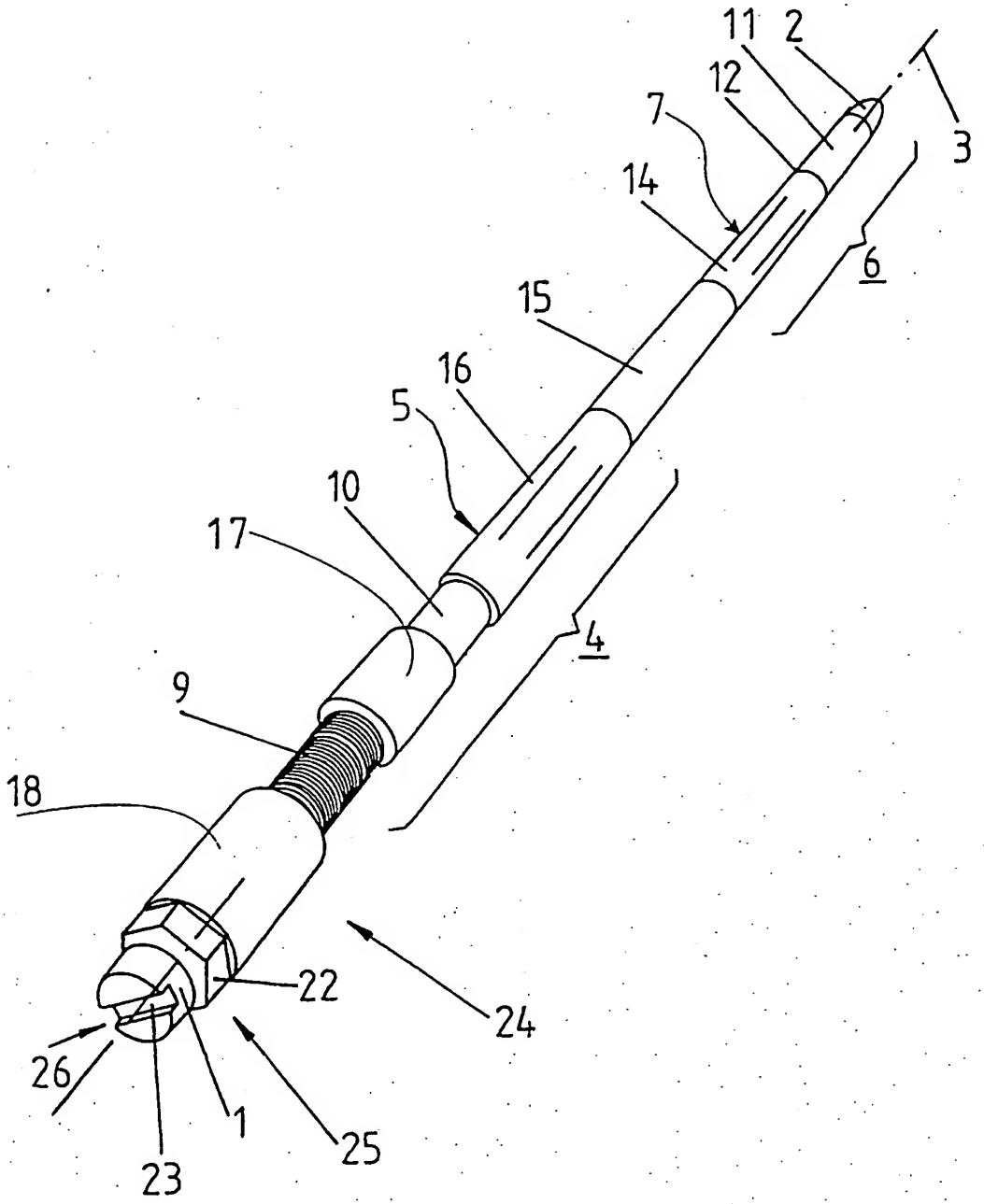

Fig. 1

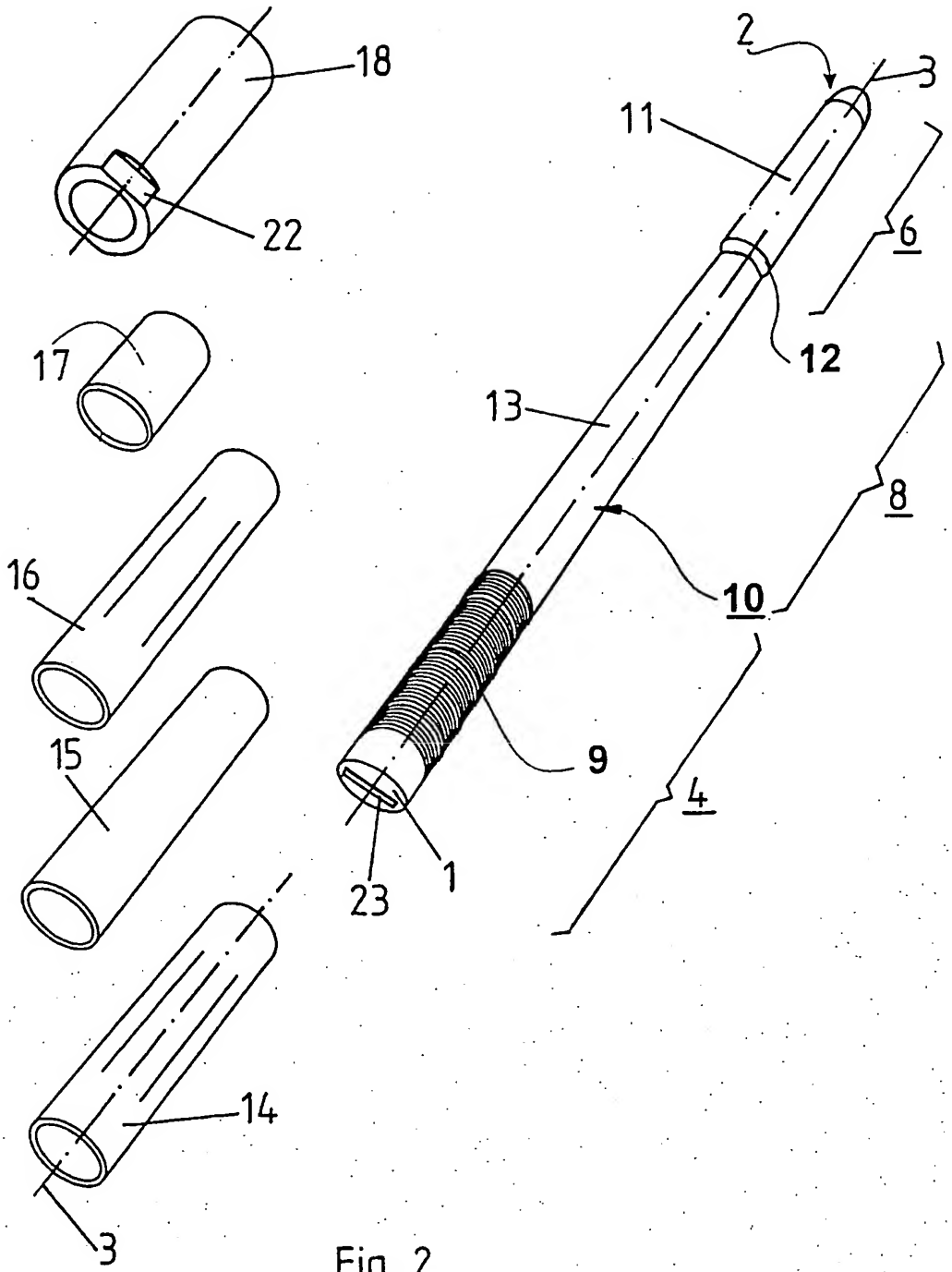

Fig. 2

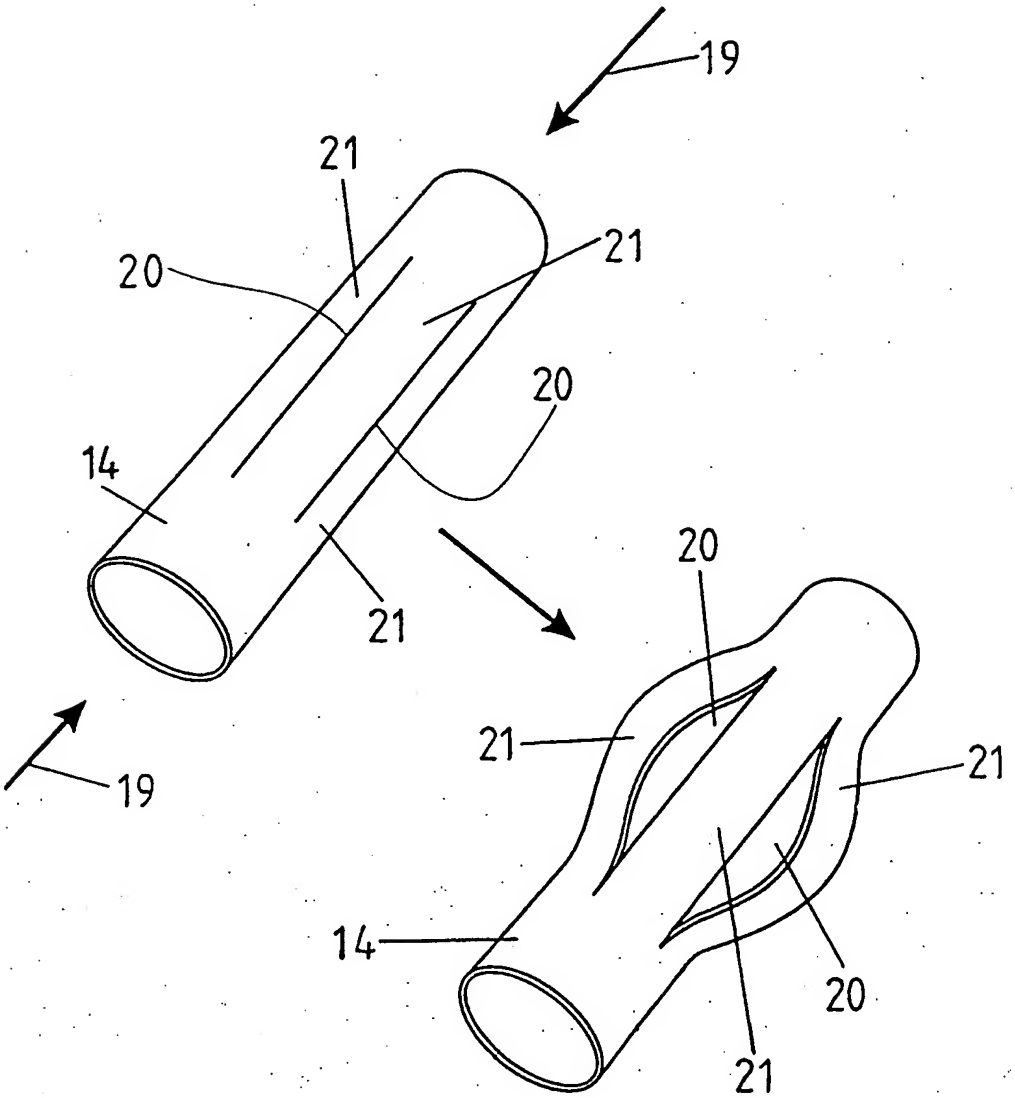

Fig.3

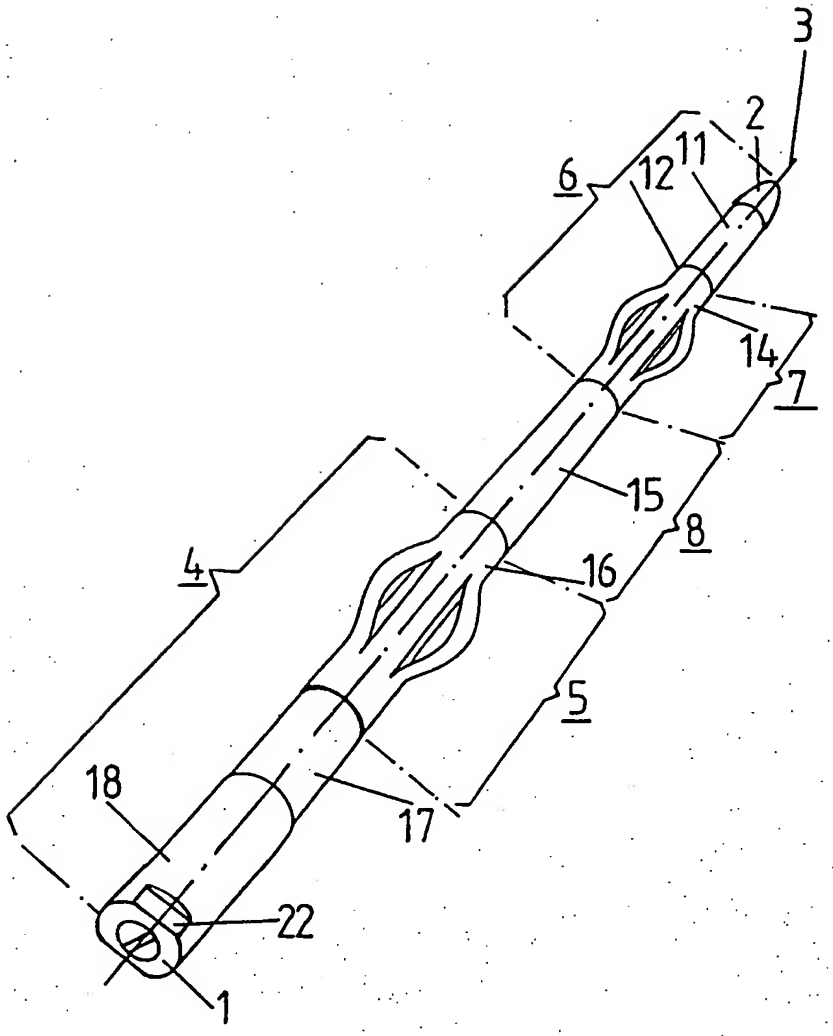

Fig. 4

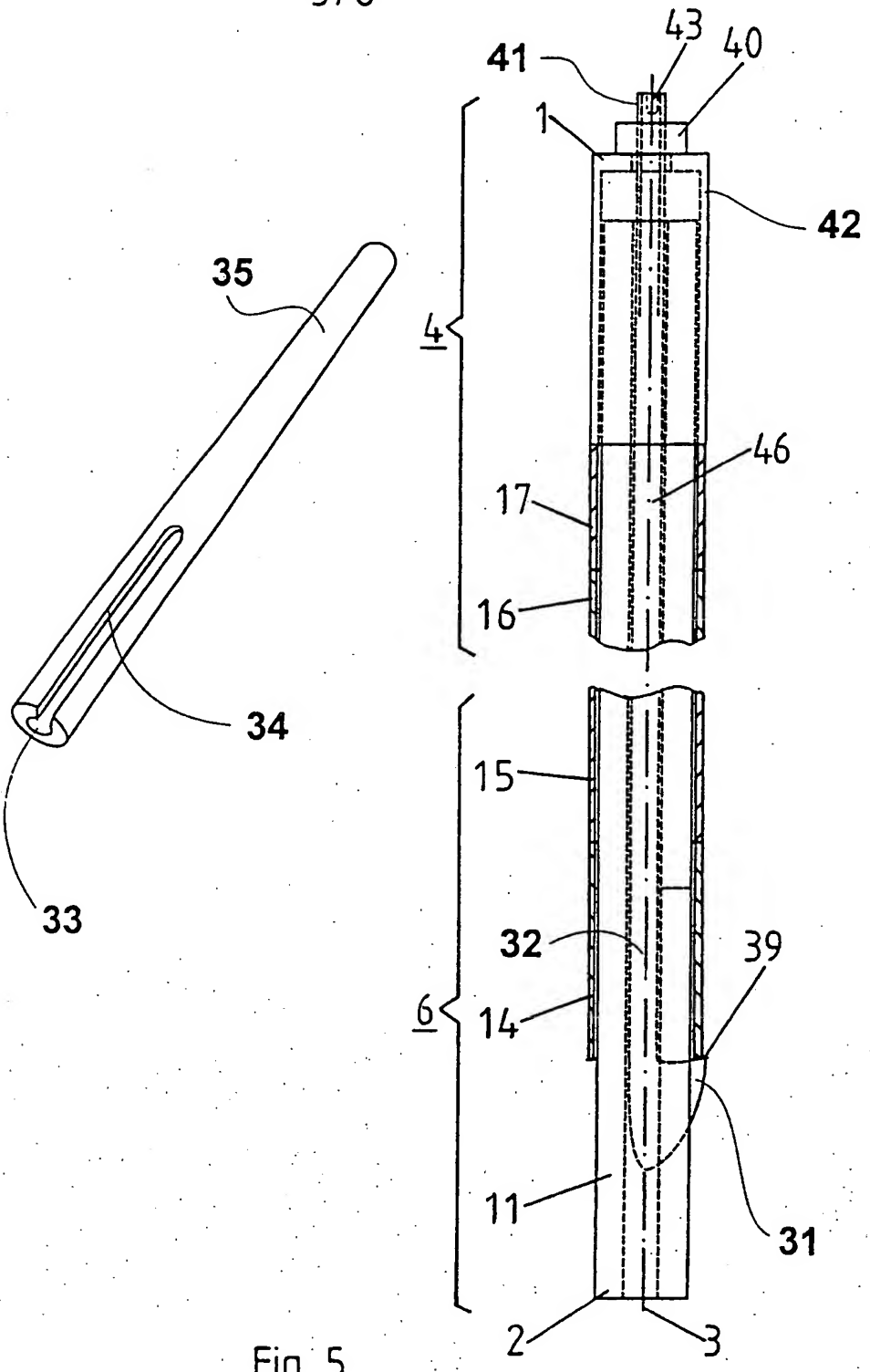

Fig. 5

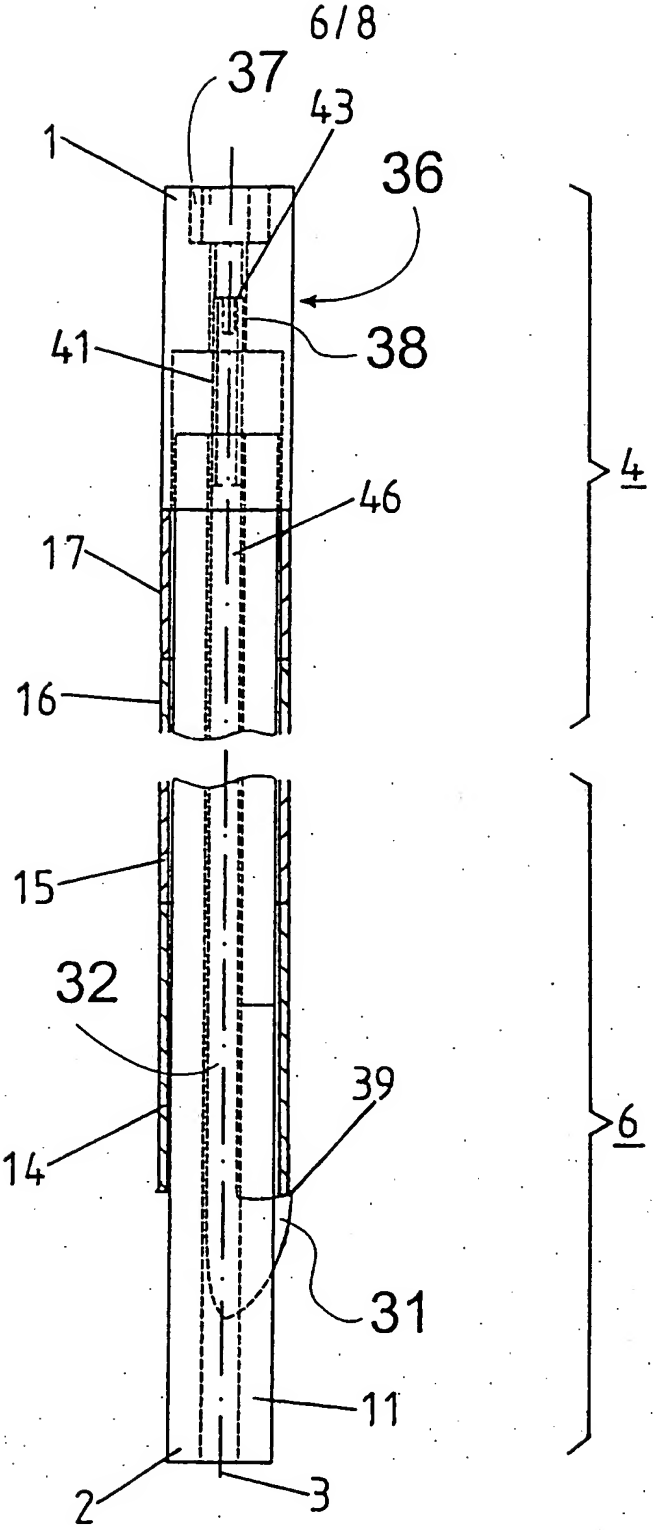

Fig.6

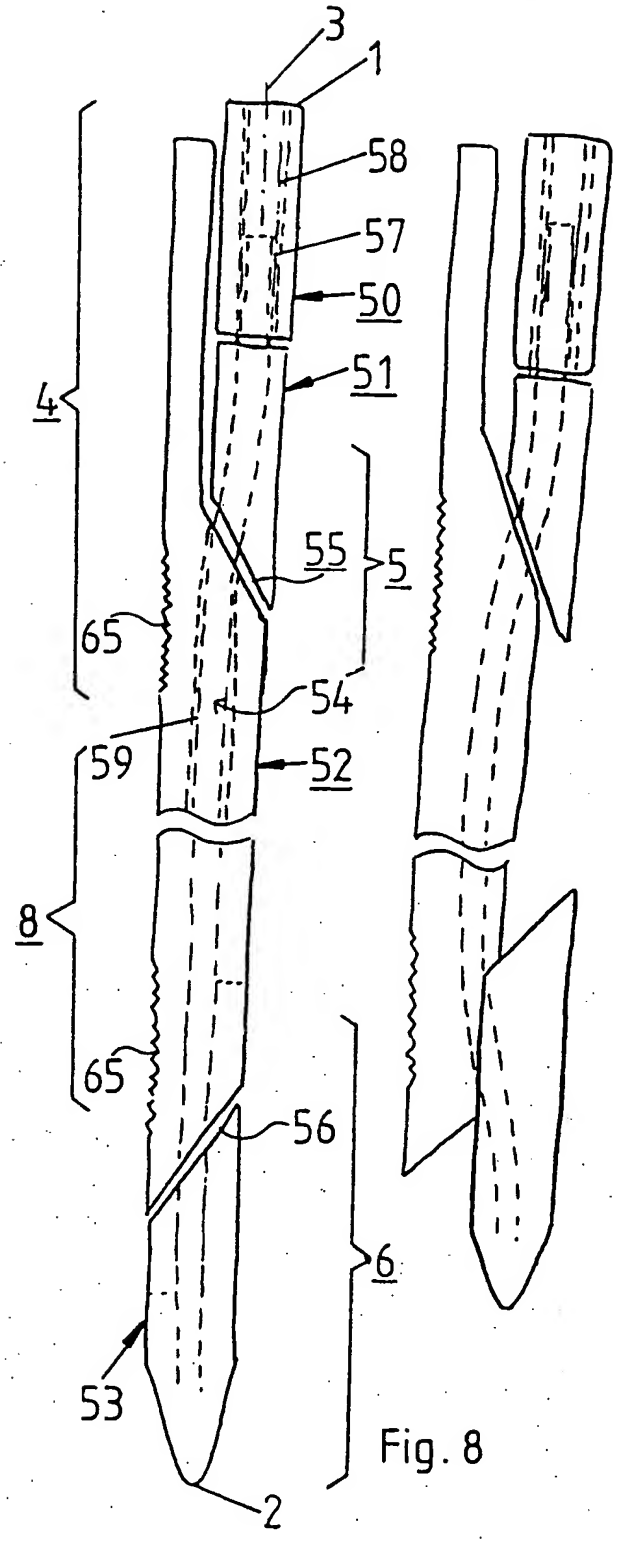

Fig. 7

Fig. 8

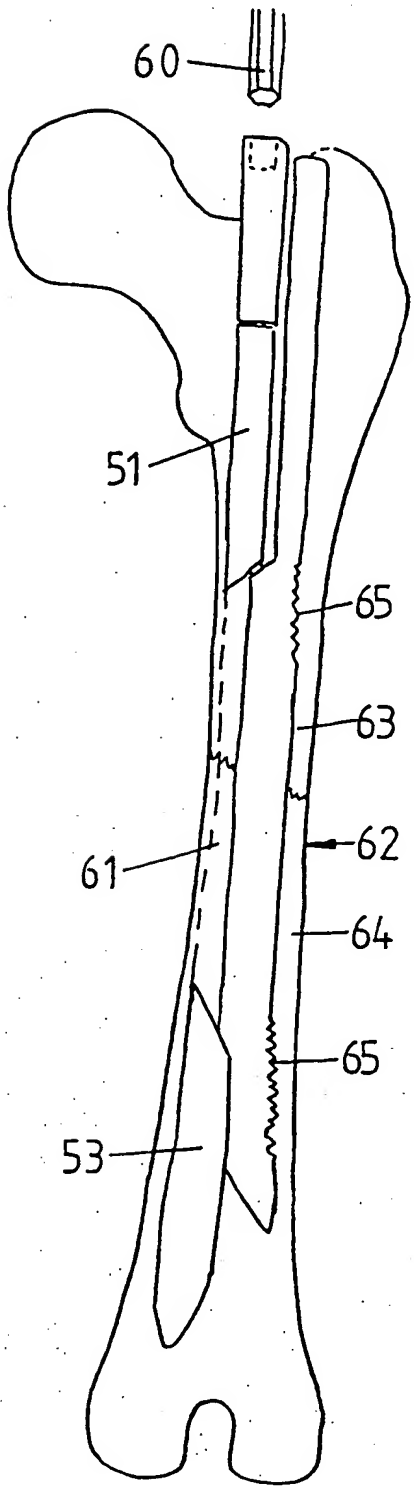

Fig. 9

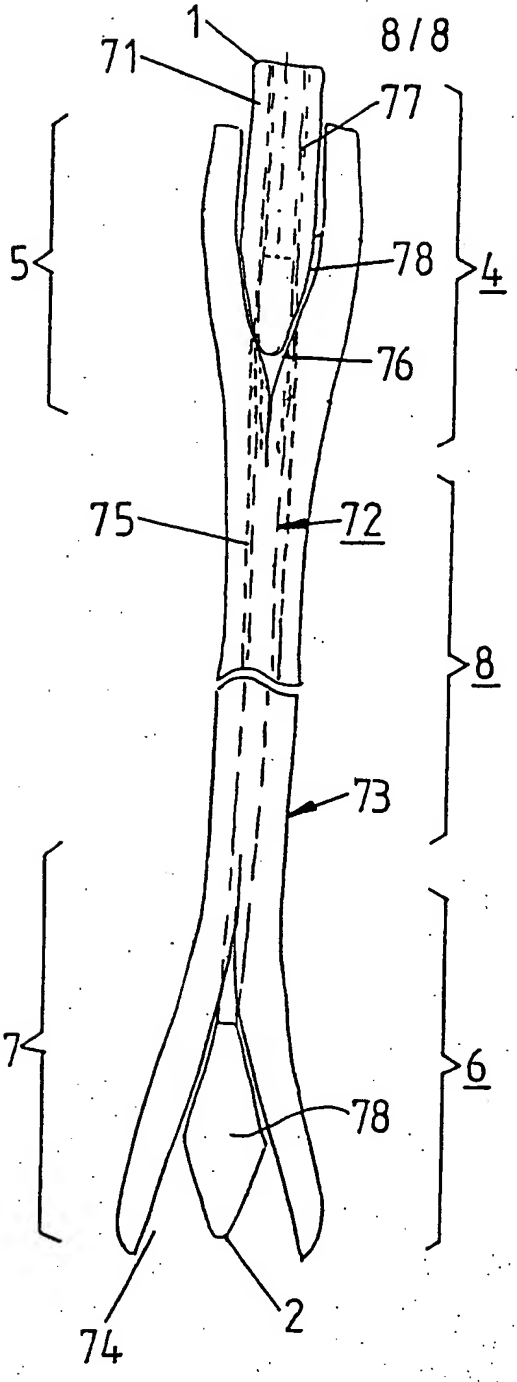

Fig.10

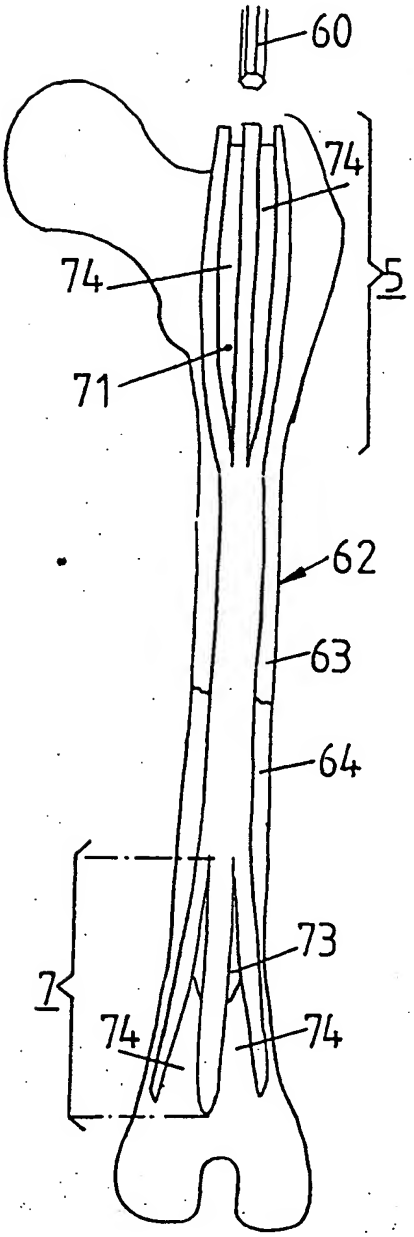

Fig.11

INTERNATIONAL SEARCH REPORT

Int. ..ational Application No
PCT/CH 99/00532

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61B17/72

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 97 18769 A (P.A.CARRUZZO AND G.SAILLANT) 29 May 1997 (1997-05-29)	1-14
A	abstract; figures 1,6 page 5, line 20 -page 6, line 7 page 6, line 29 -page 7, line 4	15,16, 18,20-26
X	GB 2 268 068 A (J.B.C.DAVIES) 5 January 1994 (1994-01-05)	1-14
A	abstract; figure 3 page 7, line 20 -page 8, line 25	15,16, 18,20-26

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
13 July 2000	20/07/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Nice, P

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PCT/CH 99/00532

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	page 5, line 17 - line 18; figure 1 page 5, line 30 -page 6, line 6 page 10, line 2 - line 29	16-19, 21,23
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A	column 3, line 40 - line 53; figures 1,4	32,33
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PCT/CH 99/00532

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